

played a prominent part in supplying us with trustworthy guides, which afford the means of tracing to their common origin many divergent lines of plant-evolution. Among other genera which have thrown new light on the course of evolution, the two Cycadofilicinean types *Heterangium* and *Lyginodendron*, dealt with in Lectures x. and xi., may be specially mentioned.

It is impossible in a short review to deal adequately with all the subjects of the lectures. A few remarks might be made by way of criticism bearing on nomenclature and terminology, but this is a matter of secondary importance. The work, as a whole, has been admirably done; its value is considerably enhanced by the fact that many of the conclusions are founded on the author's personal investigations which are characterised by ability, thoroughness and sound judgment. It may be safely said that there is no source from which the botanist can gain so clear a view of the far-reaching importance of researches into the morphology of Palæozoic plants than from the volume before us.

A. C. S.

#### PHYSICAL CHEMISTRY IN AMERICA.

*The Journal of Physical Chemistry.* Edited by Wilder D. Bancroft and Joseph E. Trevor. (Cornell University, Ithaca, New York.)

THE recent development of physical chemistry may be said to date from the year 1887. The fundamental ideas on which the modern superstructure rests had been conceived and even published before that time; but though the phase rule of Gibbs, the osmotic pressure theory of van't Hoff and the electrolytic dissociation theory of Arrhenius had all appeared in print, they were buried in the little-known transactions of minor academics, and so escaped general notice. It is undoubtedly to Ostwald that the popularisation of physical chemistry is due. Himself an unflagging worker in the field, he gathered together and systematised the work done by his predecessors in the *Lehrbuch der allgemeinen Chemie*, which was completed in 1886. In 1887 the new era began with the establishment of his *Zeitschrift für physikalische Chemie*. To the first volume of this journal, van't Hoff and Arrhenius contributed succinct accounts of those theories which have since so largely inspired and dominated physicochemical work. The extent of this work may be gathered from the fact that of the *Zeitschrift* thirty-four volumes have now been published, each volume containing on the average nearly 750 pages.

Amongst the students frequenting Ostwald's laboratory in Leipzig there has always been a large number of Americans, eager and energetic after their kind. Most were enthusiastic for the new theories, and in the best the enthusiasm was tempered by intelligent and judicious criticism, differing widely from the suspicious conservatism so often displayed in this country when these theories have been under discussion. To this happy scientific temperament we owe the fact that to-day physical chemistry is being much more thoroughly cultivated on the other side of the Atlantic than in Britain. In many, perhaps most, of the Universities it is taught as part of the student's ordinary chemical equipment, and the student who wishes to specialise in the subject can

find in Boston or at Cornell ample opportunity and encouragement for study and research.

Cornell University has published since 1897 the *Journal of Physical Chemistry* under the editorship of two of its professors. On the cover of the *Journal* for March 1899 we find that the department of chemistry offers the following courses, each of which runs through the entire year.

(1) *The Phase Rule*.—A comprehensive qualitative treatment of all types of chemical equilibrium, as these are classified by the Phase Rule of Gibbs.

(2) *The Law of Mass Action*.—Non-mathematical exposition.

(3) *Mathematical Chemistry*, I.—The mathematical theories of chemical equilibrium, of the velocities of reactions, and of electrochemistry.

(4) *Mathematical Chemistry*, II.—A systematic study of Duhem's "*Traité élémentaire de Mécanique chimique*."

(5) *The History of Thermodynamics*.—Especially consideration is given to the physicochemical applications of thermodynamic theory.

(6) *Introduction to Mathematical Chemistry*.—An elementary exposition of the essential features of: (a) the theory of surfaces, as applied in geometric representations of the thermodynamic properties of bodies; (b) spherical harmonics, as applied in the theory of diffusion; (c) the principles of least and varying action, as applied to the problems of chemical and electrochemical equilibrium.

(7) *Electrochemistry*.—Historical treatment.

(8) *The Velocities of Reactions*.—Historical account and mathematical theory.

(9) *Laboratory Work*.—Laboratory methods and experimental research.

Two or three lectures weekly are given in each course, the aggregate weekly number of lectures being twenty. Certainly no German university offers a more complete or systematic course of instruction in physical chemistry than this.

As might be expected from the countrymen of Gibbs, the lecturers give a prominent place to the application of thermodynamics to the problems of chemical equilibrium. The same predilection appears in the *Journal*, to which Duhem, the chief contemporary exponent of the subject, is a frequent contributor. Electromotive force also receives a large share of attention. The reviews of books and critical abstracts of papers on physical chemistry appearing in other publications are in general well done, being brief, clear and to the point.

The personality of one of the editors is deeply impressed on the *Journal*. His views of the physical chemistry of to-day may perhaps best be seen from the following extract, taken from a notice of the new edition of Ostwald's *Grundriss der allgemeinen Chemie*:—

"Physical chemistry is not yet a quantitative science: it is a pseudo-quantitative science. There are all the outward signs of a quantitative science. We have formulas and tables; we make use of thermodynamics and the differential calculus; but this is for the most part a vain show. Long before we reach the point where the formula is to be tested experimentally, we slip in a 'simplifying assumption'; that the concentration of one component may be considered as constant; that the heat of dilution is zero; that the solute may be treated in all

cases as though it were an indifferent gas; that the concentration of the dissociated portion of a salt may be substituted for the total concentration; &c., &c. The result is that our calculations apply at best only to limiting or ideal cases, where an error in deducing the formula may be masked by the error of observation. Helmholtz did not do this, but Helmholtz is considered old-fashioned."

What Mr. Bancroft would have us do is to study concentrated solutions. The object is most laudable; but until a Helmholtz appears who is capable of attacking the problem in all its complexity, physical chemists will probably continue their work on dilute solutions, for which the conditions are comparatively simple, and the behaviour of which is represented closely by the results deduced from a consideration of the limiting or ideal cases above referred to.

There is one point about many of the reviews (and some of the original contributions) which calls for remark—they seem needlessly scathing. Should any one be so unfortunate as to differ in opinion from the reviewer, he is forthwith tomahawked, and his scalp brandished in triumph before the horrified reader. It is painful to see one's friends—nay, even one's enemies—ruthlessly butchered in this fashion, and we would earnestly counsel a less close adherence to the former methods of the Wild West.

J. W.

#### THE EXPLORATION OF THE UPPER AIR.

*Sounding the Ocean of Air.* Being six lectures delivered before the Lowell Institute of Boston in December, 1898. By A. Lawrence Rotch, S.B., A.M. "Romance of Science" Series. Pp. viii + 184. (London: Society for Promoting Christian Knowledge, 1900.)

A CORDIAL welcome for this little book may be anticipated from the fact that it is the latest addition to the series which has given us Boys's "Soap Bubbles," Perry's "Spinning Tops," Worthington's "Splash of a Drop" and Sir R. Ball's "Time and Tide." Its author has won for himself a prominent place among those who are best acquainted with modern ways of sounding the ocean of air, by the work done at his observatory at Blue Hill, Massachusetts, and by his personal association with the observers of clouds and the users of balloons and kites in Europe.

Perhaps the very width and depth of his acquaintance with the details of the subject have made the task of the popular exposition of it in six short chapters a difficult one. The procession of facts, each one of great interest in itself, is apt to become panoramic and even kaleidoscopic; and when one page, or sometimes one paragraph, has to accommodate a succession of scientific ideas, the inexperienced reader may find himself a little bewildered with the rapidity of the transitions, and occasionally even with some short cuts to scientific conclusions.

After a short historical introduction the book deals successively with the exploration of the upper air by means of clouds, balloons and kites. Each section gives a brief account of the earlier experiments, before treating of the recent results. The romance begins in the first chapter with a striking diagram of the heights of certain observatories, mountain peaks, kites and balloons, showing one balloon—an unmanned one, be it said—

at the almost incredible height of 13 miles or more (upwards of 70,000 feet), where the corresponding barometric pressure is about one and a half inch of mercury; it culminates in the chapter describing these extremely lofty ascents. The chapters on the various types of balloon, captive balloons, free balloons and *ballons sondes* (unmanned balloons) are, both from the historic and the scientific point of view, the most interesting to the general reader. The study of clouds is clearly too large a subject for a single chapter; and the final chapters, which are devoted to the description of kites and the results obtained at Blue Hill, enter into details which the meteorologist will find of great value and interest, but which require close attention from the reader. The diagrams with which the book is illustrated have suffered a little from the reduction in scale for the purpose of reproduction; but the reader who will take the trouble to follow them carefully with the text will be rewarded by obtaining an excellent survey of the work done with kites up to a height of 12,000 feet, and some idea as to what they may be expected to accomplish in the future.

One side of the romance of kite work is only touched with a light hand. The Berlin experimenters could supply at least one thrilling story of a kite that absconded for the night with its wire, and made a long and very eventful journey; but Blue Hill has perhaps been more fortunate; doubtless its situation lends itself less easily to romantic exploits of that description.

It is interesting to notice the geographical distribution of the work of exploring the upper air as it appears in Mr. Rotch's account. Speaking quite generally, the United States are conspicuous for the work with kites, Germany for various forms of manned balloons, and France for *ballons sondes*, although the most adventurous of these last, the "Cirrus," belonged also to Berlin; while cloud work is more evenly distributed, the services of Hildebrandsson in that department render Sweden conspicuous. Great Britain is credited with an active share in the initiation or early development of the scientific exploration of the air by clouds, balloons and kites in turn, but in later years seems to have withdrawn from such enterprises.

Mr. Rotch's interesting lectures may well leave the impression that the further sounding of the upper air of the British Isles might be exciting on account of the special situation and circumstances of the islands, but, for the same reason, would be of great scientific importance.

#### OUR BOOK SHELF.

*The Locust Plague and its Suppression.* By Aeneas Munro, M.D., Edinb. and Cordova, Fellow of the Faculty of Physicians and Surgeons of Glasgow. With illustrations. Pp. xvi + 365. (London: Murray, 1900.)

THE volume before us has been prepared by the author after nearly ten years' observation of locust ravages in the Argentine Republic and in South Africa. He is profoundly convinced of the enormous damage caused by locusts in various parts of the world, and has brought together a considerable amount of information respecting the various means which have been adopted for destroying them. Dr. Munro writes from a practical point of view,